

## CLAIMS:

1. A device comprising a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria.

2. The device in accordance with claim 1, wherein said hydrogenotrophic bacteria comprise one or more species of bacteria selected from the group consisting of *Acetobacterium* spp., *Achromobacter* spp., *Aeromonas* spp., *Acinetobacter* spp., *Aureobacterium* spp., *Bacillus* spp., *Comamonas* spp., *Dehalobacter* spp., *Dehalospirillum* spp., *Dehalococcoide* spp., *Desulfurosarcina* spp., *Desulfomonile* spp., *Desulfobacterium* spp., *Enterobacter* spp., *Hydrogenobacter* spp., *Methanosarcina* spp., *Pseudomonas* spp., *Shewanella* spp., *Methanosarcina* spp., *Micrococcus* spp., and *Paracoccus* spp.

3. The device in accordance with claim 1 or 2, wherein said hydrogenotrophic bacteria comprise one or more strains of bacteria selected from the group consisting of *Acetobacterium woodi*, *Aeromonas hydrophila*, *Aeromonas sobria*, *Alcaligenes eutrophus*, *Comamonas acidovorans*, *Dehalococcoide restrictus*, *Dehalococcoide multivorans*, *Dehalococcoide ethenogene*, *Desulfobacterium tiedje*, *Enterobacter agglomerans*, *Hydrogenobacter thermophilus*, *Methanosarcina barkeri*, *Methanosarcina mazei*, *Methanosarcina thermophila*, *Paracoccus denitrificans*, *Pseudomonas aureofaciens*, *Pseudomonas maltophilia*, *Pseudomonas mendocina*, and *Shewanella putrefaciens*.

4. The device in accordance with any preceding claim, wherein said hydrogenotrophic bacteria comprise *Paracoccus denitrificans* ATCC17741, *Paracoccus denitrificans*

ATCC35512, *Paracoccus denitrificans* ATCC13543, or *Paracoccus denitrificans* ATCC19367.

- 5 5. The device in accordance with any preceding claim, wherein said zero-valent iron comprises Fe(0) metal, an Fe(0) alloy, or an Fe(0)-Ni(0), Fe(0)-Zn(0), Fe(0)-Pt(0), or Fe(0)-Pd(0) bimetal.
- 10 6. The device in accordance with any preceding claim, wherein said zero-valent iron comprises filings, shavings, turnings, wool, powder, mesh, beads, rods, pellets, or flakes.
- 15 7. The device in accordance with any preceding claim, further comprising a support.
- 20 8. The device in accordance with any preceding claim, further comprising a glass, concrete, metallic, zeolite, mineral, fiber, fiberglass, ceramic, plastic, polymeric, or resin support.
- 25 9. The device in accordance with any preceding claim, comprised within an environmental site.
- 30 10. The device in accordance with any preceding claim, comprised within a landfill site, an agricultural site, an agricultural runoff site, or an irrigation site.

11. The device in accordance with any preceding claim, further defined as an *in situ* reactive barrier.

5 12. The device in accordance with claim 11, further defined as a permeable barrier, a semipermeable barrier, a treatment wall, and injected treatment zone, or a funnel and gate system.

Sub A3 10 13. The device in accordance with any one of claims 1 to 8, further defined as an *ex situ* bioreactor.

14. The device in accordance with claim 13, comprising an inlet port, an outlet port and a container means for containing said composition.

Sub A4 20 15. The device in accordance with claim 13 or 14, further defined as a continuous culture system, a flow-through packed column, an inline water filter, a biofermenter, a fluidized bed, a sequencing batch reactor, or an anaerobic digester.

16. The device in accordance with any one of claims 13 to 15, comprised within a water-wastewater- or sewage-treatment system.

17. The device in accordance with claim 16, comprised within a water treatment system, a sewage or wastewater treatment system, a municipal water supply system, or a pollution decontamination system.

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18. The device in accordance with any preceding claim, comprised within a system for remediating pollution in an aqueous solution or an environmental site.

5 19. A device in accordance with any preceding claim, for use in detoxifying or remediating an aqueous solution or an environmental site.

10 20. A device in accordance with any one of claims 1 to 18, for use in treating environmental pollution.

15 21. A device in accordance with any one of claims 1 to 18, for use in treating agricultural leachate, water, wastewater, groundwater, surface water, an aquifer, or sewage.

20 22. A device in accordance with any one of claims 1 to 18, for use in reducing the concentration of a nitrogen- or sulfur-containing compound in an aqueous solution or an agricultural site.

25 23. The device in accordance with claim 22, wherein said nitrogen- or sulfur-containing compound comprises nitrate, nitrite, sulfate, or sulfite.

30 24. A device in accordance with any one of claims 1 to 18, for use in reducing the concentration of a haloaromatic or nitroaromatic compound in an aqueous solution or an agricultural site.

25. The device in accordance with claim 24, wherein said wherein said nitroaromatic compound is trinitrotoluene, RDX, HMX, 2-aminodinitrotoluene, 4-aminodinitrotoluene, or parathion, and said haloaromatic compound is tetrachlorodibenzodioxin pentachlorophenol, chlorobenzoate, atrazine, or 1,1,1-TCA.

26. A device in accordance with any one of claims 1 to 18, for use in reducing the concentration of a metal ion-containing compound in an aqueous solution or an agricultural site.

27. The device in accordance with claim 26, wherein said metal ion-containing compound comprises strontium (II), cesium (I), chromium (VI) uranium (VI), technetium (VII), silver (I), or mercury (II).

28. A device in accordance with any one of claims 1 to 18, for use in removing or reducing the concentration of a pesticide in an aqueous solution or an environmental site.

29. The device in accordance with claim 28, wherein said pesticide comprises methoxychlor, alachlor, metolachlor, lindane, DDT, DDE, DDD, dieldrin, aldrin, heptachlor, chlordane, 2,4-dichlorophenoxyacetic acid, 2,4,5-trichlorophenoxyacetic acid or atrazine.

30. Use of a device in accordance with any one of claims 1 to 18, in the manufacture of a apparatus for removing or reducing the concentration of an organic or an inorganic compound in an aqueous solution or an environmental site.

31. Use of a device in accordance with any one of claims 1 to 18, in the manufacture of a system for remediating pollution.

5 32. Use of a device in accordance with any one of claims 1 to 18, in the manufacture of a water, a wastewater, or a sewage treatment apparatus.

10 33. Use of a device in accordance with any one of claims 1 to 18, in the manufacture of an apparatus for reducing the concentration of an organic or an inorganic compound in an aqueous solution or in an environmental site.

Sub A 15 34. A method of removing or reducing the concentration of an organic or inorganic compound in an environmental site, comprising providing to said site an effective amount of a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

20 35. A method for denitrifying groundwater or an environmental site *in situ* comprising contacting said groundwater or said environmental site with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

25 36. A method for removing or reducing the concentration of a nitrogen- or sulfur-containing compound in a sample, comprising contacting a sample suspected of containing said compound with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

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37. The method in accordance with claim 36, wherein said nitrogen-containing compound is nitrate or nitrite, and said sulfur-containing compound is sulfate or sulfite.

5 38. The method in accordance with claim 36 or 37, wherein said nitrogen-containing compound is nitrate or nitrite.

10 39. A method for removing or reducing the concentration of a nitroaromatic compound in a sample, comprising contacting a sample suspected of containing said nitroaromatic compound with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

15 40. The method in accordance with claim 39, wherein said nitroaromatic compound is trinitrotoluene, RDX, HMX, 2-aminodinitrotoluene, 4-aminodinitrotoluene, or parathion.

20 41. The method in accordance with claim 39 or 40, wherein said nitroaromatic compound is trinitrotoluene, RDX, or HMX.

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42. A method for removing or reducing the concentration of a halocarbon compound in a sample, comprising contacting a sample suspected of containing said halocarbon with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

30 43. The method in accordance with claim 42, wherein said halocarbon is carbon tetrachloride, dichloromethane, a polychlorinated biphenyl, a chlorinated benzene, trichloroethylene, perchloroethylene, dichloroethylene, vinyl chloride, chloroethane,

bromoform, dichlorodifluoromethane, trihalomethanes, tetrachlorodibenzodioxin pentachlorophenol, a chlorobenzoate, atrazine, or 1,1,1-TCA.

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44. The method in accordance with claim 42 or 43, wherein said halocarbon is carbon tetrachloride, dichloromethane, trichloroethylene, perchloroethylene, dichloroethylene, vinyl chloride, chloroethane, dichlorodifluoromethane, trihalomethanes, tetrachlorodibenzodioxin pentachlorophenol, a chlorobenzoate, atrazine, or 1,1,1-TCA.

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45. The method in accordance with any one of claims 42 to 44, wherein said halocarbon is carbon tetrachloride, trichloroethylene, or dichloromethane.

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46. A method for removing or reducing the concentration of a haloaromatic compound in a sample, comprising contacting a sample suspected of containing said haloaromatic compound with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

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47. The method in accordance with claim 46, wherein said haloaromatic compound is a polychlorinated biphenyl, a chlorinated benzene, tetrachlorodibenzodioxin pentachlorophenol, a chlorobenzoate, atrazine, or 1,1,1-TCA.

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48. A method for degrading or detoxifying a pesticide, comprising contacting a sample suspected of containing said pesticide with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

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49. The method in accordance with claim 48, wherein said pesticide is methoxychlor, alachlor, metolachlor, lindane, DDT, DDE, DDD, dieldrin, aldrin, heptachlor, chlordane, 2,4-dichlorophenoxyacetic acid, 2,4,5-trichlorophenoxyacetic acid or atrazine.

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50. The method in accordance with claim 48 or 49, wherein said pesticide is atrazine.

- 10 51. A method for detoxifying a metal ion-containing compound, comprising contacting a sample suspected of containing said compound with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

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52. The method in accordance with claim 51, wherein said compound comprises strontium (II), cesium (I), chromium (VI) uranium (VI), technetium (VII), silver (I), or mercury (II).

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53. The method in accordance with claim 51 or 52, wherein said compound comprises chromium (VI) or uranium (VI).

- 25 54. A method for reducing the concentration of nitrite-, nitrate-, sulfite-, or sulfate-containing compound in an aqueous solution or environmental site, comprising (a) selecting an aqueous solution or an environmental site containing said compound; and (b) contacting said solution or site with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any

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one of claims 1 to 18.

55. A method for reducing the concentration of a nitroaromatic compound in an aqueous solution or environmental site, comprising (a) selecting an aqueous solution or an environmental site containing said nitroaromatic compound; and (b) contacting said solution or site with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

56. A method for reducing the concentration of a pesticide or organic pollutant in an aqueous solution or environmental site, comprising (a) selecting an aqueous solution or an environmental site containing said pesticide or pollutant; and (b) contacting said solution or site with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

57. A method for reducing the concentration of a mercury-, silver-, technetium-, strontium-, cesium-, chromium- or uranium-containing pollutant in an aqueous solution or environmental site, comprising (a) selecting an aqueous solution or an environmental site containing said pollutant; and (b) contacting said solution or site with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.

58. A method for reducing silver (I), mercury (II), technetium (VII), strontium (II), cesium (I), chromium (VI) or uranium (VI) ions in an aqueous solution, comprising contacting an aqueous solution suspected of containing one or more of said ions with a composition comprising zero-valent iron and a culture of one or more hydrogenotrophic bacteria, or a device in accordance with any one of claims 1 to 18.